# Appendix F

## New Technology for Improving System Capacity

The major purpose of the Research, Engineering, and Development (R,E&D) program is to develop and exploit technologies in an effort to increase system capacity and fully utilize capacity resources, accommodate user-preferred flight trajectories, increase user involvement in air traffic management decision-making, and develop air traffic control and aircraft systems that enhance overall safety at the increased levels of operations forecasted for the 21st century.

## Major FY1990-91 Accomplishments

During FY1990-91, the FAA's Capacity R,E&D program made the following advances:

- Successful demonstration of conducting independent IFR approaches to parallel runways spaced 3,400 ft. apart
- Approval of simultaneous IFR approaches to the proposed triple and quadruple parallel runways at Dallas/Ft. Worth International Airport
- The use of computer-based analytical models for airspace capacity and design studies for 13 airports
- Field evaluations of the Converging Runway Display Aid and laboratory evaluation of the Center-TRACON Automation System
- The installation and test of track generation programs and traffic management displays in New York, Oakland, and Anchorage ARTCC's for oceanic ATC
- Reduction in vertical separation standards from 2,000 ft. to 1,000 ft. above FL 290
- Airport capacity design team studies completed for 11 airports; 8 still underway, 5 new ones being considered for 1992, and new runways planned for 7 airports
- Installation of MLS's at New York (JFK) and Chicago (Midway) to evaluate capacity enhancements at runways on which an ILS cannot be installed

# Current Program

Complete project details, including funding and implementation dates, where appropriate, are given in the following pages. The key elements of the R,E&D capacity program are:

- ATC Technology Program - To enhance the operational capabilities of the air traffic control system through the aggressive introduction of automation. Such projects include Advanced Traffic Management System, Oceanic Display and Planning System, Dynamic Ocean Tracking System, Automatic Dependent Surveillance, AERA, Terminal ATC Automation, Airport Surface Traffic Automation, Airport Movement Safety System, Airport Capacity Improvements, and Wake Vortex Avoidance/Advisory System.
- Aircraft Technology Program - To develop aircraft technologies to enhance ATC capacity and efficiency by enabling aircraft to safely assume some aspects of the air traffic controller's current responsibilities for ensuring aircraft separation and to develop operational procedures and certification criteria to exploit the capabilities of rotorcraft and tiltrotor aircraft. The projects in this program are Traffic Alert and Collision Avoidance System, Cockpit Display of Traffic Information, and Vertical Flight Operations and Certification.
- Future Systems Engineering Program - To develop and maintain the necessary steps required for successful integration of the new and proposed subsystems into the evolving ATC system. This program includes Future System Definition, Flight Operations and ATM Integration, Separation Standards, Integrated Traffic Flow Management, and NAS System Operational Concepts.
- Capacity Planning - To develop technological (other than ATC), procedural, and airport design alternatives which will increase the operational capacity of the system. These projects include airport design, airspace design, and approach procedures.
- Modeling and Simulation Program - To develop tools to plan and implement the Capacity and ATC Technology Program, to develop new facilities to realistically simulate the operation of future air traffic control systems, to develop new models and research techniques to analyze, assess impacts, and guide the long-term technological evolution of the National Airspace System, and to integrate the major pieces of the system so that they play in harmony with one another. The projects include the National Simulation Laboratory, Operational Traffic Flow Planning, Traffic Models and Evaluation Tools, and Airports and Airspace Impacts Assessments.

The projects described above are explained in detail in the following section. They are divided into four categories: Terminal Airspace Capacity Related Projects, Other Capacity Related Projects, En Route Capacity Related Projects, and Airport Capacity Related Projects.

# F.1 Terminal Airspace Capacity Related Projects

## F.1.1 Terminal Radar (ASR) Replacement Program

Responsible Division: ANR-200
Contact Person: Gerald Taylor, 202/606-4574

### Purpose

*To provide economical radar service at airports with air traffic densities high enough to justify the service and upgrade the highest density airports with the latest state-of-the-art equipment.*

ASR-4/5/6 radars need to be replaced because of the decreasing availability of spare parts and the high-maintenance workload. Furthermore, repair parts for the ASR-4/5/6 radars are in short supply. A total of 96 ASR-4/5/6 radars are being replaced. Of these, 40 ASR-4/5/6 sites are being upgraded to ASR-9's, 40 ASR-4/5/6's are being upgraded to ASR-8's, and 16 ASR-4/5/6's are being upgraded to ASR-7's, a procedure called "leapfrogging."

### Program Milestones

The first ASR-9 Operational Readiness Demonstration (ORD) was in FY1989 and the first leapfrog ORD was in FY1990. The last leapfrog ORD is scheduled for FY1993 and the last ASR-9 ORD is planned for FY1994.

### Products

- Replace 96 radars
- Leapfrog 56 radars

## F.1.2 Los Angeles Basin Consolidation

Responsible Division: ANS-300
Contact Persons: Frank McArthur, 202/267-8680
Bill Henshaw, FTS/984-0220

### Purpose

*To consolidate five Los Angeles Basin Terminal Radar Approach Control Facilities (TRACONs) to be known as the Southern California TRACON. This new facility will enhance traffic management in Southern California and allow more efficient use of the airspace.*

The Los Angeles Basin is created by the Pacific Ocean and the San Rafael, Sierra Madre, Techachapi, San Gabriel, San Bernardino, San Jacinto, and Santa Ana Mountain ranges. The basin area is approximately 75 miles wide and 100 miles long. The major portion of this airspace below 10,000 feet is currently controlled by TRACON facilities located at Los Angeles, Burbank, El Toro (coast), Ontario, and San Diego. These five TRACON facilities provide instrument flight rule services for 29 airports within their respective areas of jurisdiction. This includes eight major air carrier airports and five military air fields. Instrument operations in Southern California have increased 122 percent over the last two years to 2,700,000 instrument operations. Forecasts call for well over 3,000,000 operations by the year 2000.

### Products

This consolidation will enhance safety, improve airspace utilization, and provide an IFR air traffic control system approach for the major hub and satellite reliever airports in Southern California.

- Start site adaptation .................................... 01/90
- Building contract award (completed) ............ 09/91
- Building occupancy date ............................. 02/93
- Los Angeles TRACON consolidated ............. 12/93
- Coast TRACON consolidated ........................ 05/94
- Burbank TRACON consolidated .................... 10/94
- Ontario TRACON consolidated ..................... 04/95
- San Diego TRACON consolidated ................. 09/95
- Project completed ....................................... 02/96

## F.1.3 Simulation Model Development (SIMMOD)

Responsible Division: AOR-200
Contact Person: Jake Plante, 202/267-3539

### Purpose

*To provide an accurate, comprehensive, and cost-effective analytical tool for evaluating proposed improvements to the national airspace system.*

This capability will provide quantitative analyses to determine the impact of proposed changes to airports, airspace, and aircraft traffic. The FAA Airport and Airspace Simulation Model (SIMMOD) will play a significant role in future development of the national airspace system by reliably identifying the most appropriate airport and airspace design and procedural alternatives.

SIMMOD will be enhanced with logic improvements that will increase realism in simulating the actual behavior of the air traffic control system and air operations. The cost of extensive data preparation will be reduced by developing automated data-acquisition hardware and software. Visual replay of scenarios will continue to be developed as an effective quality-control technique and for specific site calibration. Full documentation of the model's algorithms has been provided, as well as training manuals and courses, so that the model may be widely used by the FAA and others to improve designs and procedures in the airspace system.

### Program Milestones

Version 1.0 of SIMMOD was validated in FY1988 and publicly released in FY1989. Through FY1990, SIMMOD has been applied to numerous airspace design tasks at Los Angeles, Boston, Dallas-Ft. Worth, Denver, Chicago, Kansas City, Houston-Austin, New York (Phase I), and Miami. Studies that focused on airport design and ground operations during this period include San Diego, Salt Lake City, Portland, Milwaukee-Mitchell, and Minneapolis-St. Paul. SIMMOD was used outside the United States for airport and airspace capacity studies at Madrid, Majorca, Quebec, Toronto, Ottawa, Hong Kong, Sydney and Melbourne.

In FY1991, SIMMOD continued to be used for major airspace capacity and design studies at Cleveland, Washington, New York (Phase II), Oakland, Jacksonville, and Atlanta. The model has been purchased by 145 organizations, many of which are applying the model in numerous locations for airline, airport, and government agencies.

For FY1992, applications work will continue for both airport and airspace environments. In addition, Version 2.0 of SIMMOD will be completed. This version, available for workstations, will be significantly faster than that for microcomputers. This version will include better graphical output displays and automated data-acquisition capability. For example, SIMMOD will generate output data that can be used directly by other FAA models, including the Integrated Noise Model used for environmental studies.

### Products

- Complete computer program for workstations and microcomputers
- An organization of users throughout the FAA and industry
- Training sessions, manuals, and technical documentation for users

## F.1.4 Terminal ATC Automation (TATCA)

Responsible Division: ARD-40
Contact Person: Peter Challan, 202/267-7335

### Purpose

*To develop automation aids to assist air traffic controllers and supervisors in overcoming the limitations of the terminal area air traffic management process, and to facilitate the early implementation of these aids at busy airports.*

The TATCA program consists of two projects: the Converging Runway Display Aid (CRDA), and the Center-TRACON Automation System (CTAS). CRDA provides geometric spacing aids for aircraft by means of software changes within existing ARTS terminal radar processors. The CRDA project is in a field evaluation phase.

The CTAS project is now in laboratory development. CTAS uses auxiliary workstation processors interfaced to existing ATC processors to project the future location of aircraft, develop a coordinated and fuel efficient arrival traffic plan, and provide ATC advisories to help controllers meet the plan. The earliest CTAS products are a Traffic Management Advisor (TMA) and Descent Advisor (DA) for the Air Route Traffic Control Center and a Final Approach Spacing Tool (FAST) for the TRACON.

TMA is a scheduling tool while DA is a tool for providing fuel-efficient descent profiles to meet the arrival plan specified by the TMA. These are automation aids for sequencing and spacing aircraft from the top of the descent point to the terminal area. FAST is a final approach sequencing and spacing tool.

Longer term TATCA activities focus on fully developed terminal automation techniques integrated with other ATC and cockpit automation capabilities of the Advanced Automation System (AAS).

### Program Milestones

CRDA is currently being evaluated at Lambert-St. Louis International Airport. When the field development is complete, national implementation will proceed for up to 30 airports with converging or intersecting runways.

CTAS laboratory evaluations and demonstrations have been completed. A preliminary plan and design was completed for the important task of implementing interfaces to the ARTS IIIA and IIIE for FAST.

### Products

- Major CRDA milestones include:
  - Complete evaluation at St. Louis.................. 11/91
  - Begin national implementation .................... 07/92
  - Complete national implementation ............. 03/93
- Major TMA milestones include:
  - Test field prototype at FAA Tech Center........ 09/91
  - Develop TMA prototype at ARTCC ............... 05/92
  - Evaluation of TMA at FAA Tech Center......... 11/92
  - Site testing of TMA ..................................... 05/93
  - Implementation at first site .......................... 10/93
- FAST milestones include:
  - Complete laboratory development of FAST ... 03/92
  - Test FAST concept at FAA Tech Center ......... 06/92
  - Field development for system specs .............. 03/93
  - Evaluation of FAST at FAA Tech Center ........ 10/93
  - Site testing of FAST ..................................... 09/94
  - Implementation of FAST at first site .............. 06/95
- The major TATCA/AAS milestone is:
  - Modification to the System Level Specification for the AAS ............................. 04/94

## F.1.5 Airport Surface Traffic Automation (ASTA)

Responsible Division: ARD-50
Contact Person: Mike Harrison, 202/267-8556

### Purpose

*To develop airport surface surveillance, communications, and automation techniques that will provide an effective runway incursion prevention capability.*

*To provide departure traffic management to sequence aircraft to the departure end of the runway according to schedules designed to expedite traffic flow and increase the capacity of the airport surface in all weather conditions.*

*To provide a linkage of information between terminal air traffic control automation tools.*

ASTA improvements will be developed in three phases. ASTA-1 will focus on the prevention of runway incursion based on use of radar surveillance (ASDE-3 data), runway/taxiway signal lighting, and an interface for the tower controller, providing appropriate advisories and alerts regarding aircraft movements. These will serve as enhancements to the Airport Movement Area Safety System (AMASS).

ASTA-2 will include surveillance and automation features that will monitor aircraft movements and coordinate traffic planning and sequencing. Initial elements for the departure traffic management capability will be introduced in Phase 2.

ASTA-3 will add a data-link communications capability.

### Program Milestones

The ASTA project was started in FY1989 to reduce the risk of runway incursions and improve airport capacity through better departure traffic management and increased efficiency of aircraft surface movements. In FY1990, alternative capabilities for reducing runway incursions were identified. In addition, a preliminary system was defined. Planned work includes the following:

- Field validation and testing ............................ 08/92
- System design contract award ......................... 10/92
- AMASS production contract award.................... 11/92
- Demonstration of ASTA-1 (Boston) ................ 12/92
- Functional specifications for ASTA-2 ............... 02/92
- Prototype competition ASTA-2 ........................ 06/94
- Production award ASTA-2 ............................... 10/94
- Delivery of first AMASS system ........................ 11/94
- ASTA-3 data link added .................................. 08/95

### Products

- 29 AMASS hardware and software enhancements for each of the ASDE-3 locations
- ASTA-1 at 29 ASDE-3 locations
- ASTA-2 at 100 to 150 airports

## F.1.6 Low Cost Surface Detection Alternatives

Responsible Division: ARD-50
Contact Person: Mike Harrison, 202/267-8556

### Purpose

*To review technologies other than ASDE-3 for the detection and alerting of runway incursions at towered airports not equipped with ASDE-3.*

### Program Milestones

Other alternatives to ASDE-3 have been identified. For FY1991 the capabilities of these systems will be analyzed, with respect to accuracy, and candidate systems with the potential for rapid procurement will be identified. A broad agency announcement soliciting alternative technologies was issued in July 1991. Contract awards demonstrating these alternatives are scheduled for FY1992. Those that are promising will be expanded to full-scale airport demonstrations.

### Products

Product examples include:

- Demonstration of GPS for ground navigation
- Surface pressure sensor for controlling lights
- Specifications for surface surveillance system using aircraft beacon codes

## F.1.7 TCAS II Applications to Improve Capacity

Responsible Division: ARD-300
Contact Person: Tom Williamson, 202/267-8465

### Purpose

*To identify and evaluate potential applications of the Cockpit Display of Traffic Information (CDTI) provided by TCAS for improving the efficiency, capacity, and safety of aircraft operations.*

*To determine which applications are worthwhile and develop the standards and procedures required for their operational implementation.*

CDTI has the capability of increasing the efficiency and capacity of the National Airspace System (NAS), reducing controller workload and, at the same time, increasing the level of safety. With the advent of TCAS, pilots will have an electronic display of nearby traffic in the cockpit.

A user group consisting of air carrier pilots, general aviation pilots, and air traffic controllers will be convened to identify and prioritize potential CDTI applications. The most promising of these applications will be evaluated by a combination of analysis, fast-time and real-time person-in-the-loop simulations, and flight tests. Consideration will be given both to applications which can use the TCAS display "as is" and ones that require additional information and enhanced display capability. For each studied application, the impact on flight safety will be assessed, procedures will be developed, and any special data and/or display requirements will be defined.

### Program Milestones and Products

- Identification of near-term CDTI applications ........ 12/92
- Safety assessment of near-term applications ..... 12/93
- Display requirements for CDTI ........ 12/93
- Implementation of CDTI use ........ 07/94
- Identification of long-term CDTI applications ........ 07/94
- Safety assessment of long-term CDTI applications ........ 01/95
- Implementation of long-term CDTI applications ........ 01/97

# F.2 Other Capacity Related Projects

## F.2.1 FAA National Simulation Laboratory (NSL)

Responsible Division: AOR-20
Contact Person: Randall J. Stevens, 202/267-7056

### Purpose

*To establish the NSL to assess proposed future subsystems, aviation procedures, airspace organization, and human factors in an integrated fashion to determine the definition of the 21st century NAS.*

The NSL will provide a means of analyzing and experimenting with alternative concepts for potential NAS development, as well as a capability for hands-on development of prototype configurations for future NAS integration. This will enable improved assessment of new concepts and high-level system design, new technologies, system requirements, potential problems, and issues. Resulting requirements specifications for procuring NAS equipment will be more accurate, complete and achievable. The initial effort has been to establish the Integration and Interaction Laboratory (I-Lab) as a proof-of-concept.

The NSL will feature rapid prototyping, configuration, modularity, flexibility, and expandibility to address research, engineering, and development ATC issues and provide feedback to interacting programs. Initial NSL capabilities will be derived from the I-Lab. This base will be expanded through FY1992 to support the conduct of human-in-the-loop simulations of the future En route, Terminal, and Traffic Flow Automation. The functionality will be extended in FY1993 to incorporate human-in-the-loop inter-operability simulations adding oceanic and an interface with applicable weather dissemination subsystems. Applicable TCAS enhancements, such as using TCAS for flight-following, will also be incorporated. Results will provide tangible support for operational suitability and the efficacy of proposed future enhancements within the NAS.

### Program Milestones

In FY1990, the FAA initiated the I-Lab Project. Initial development included facility preparation, commercial equipment and software procurement, and software infrastructure development. FY1990 activities culminated in an illustration of technical feasibility by creating an integrated, interactive simulation encompassing six existing prototypes. The illustration supported arrival and departure control within the New York Metroplex.

During FY1991, the I-Lab completed the integration of initial hardware (common console and cockpit mockups) and commercial off-the-shelf software procurements. Development activities included addition of prototypes and simulations of AERA services (en route automation) and components of the Center TRACON Automation System (CTAS). Initial NSL technical planning will be completed and preliminary steps will be taken to establish the NSL.

In FY1992, the I-Lab will complete establishment of its initial experimentation capability including central simulation control. This will extend the concepts illustrated in the proof-of-concept and provide the capability to conduct experimentation with operational personnel. The initial experiments will assess alternatives for interaction between traffic flow management and controller automation aids in the en route and terminal airspace. Detailed NSL planning will continue.

The NSL is expected to begin operation in FY1993 by porting I-Lab simulations and prototypes to the more capable processors expected to be available. I-Lab experimentation will continue in parallel.

### Products

- Operational I-Lab/NSL experimentation capability to support assessments of interaction and inter-operability among ATC (including aircraft) automation elements and human-in-the-loop performance
- Simulation results from alternative configurations of proposed future systems

## F.2.2 Dynamic Special-Use Airspace Management

Responsible Division: ARD-100
Contact Person: Stephen Alvania, 202/267-3078

### Purpose

*To develop automation capabilities and operational requirements for enhancing the ability of FAA and DoD to dynamically coordinate the use of military Special Use Airspace (SUA).*

The current manual methods for coordinating the use of military SUA between FAA and DoD operational entities do not allow for the timely exchange of information, thereby limiting the ability of the FAA to efficiently manage the NAS airspace or to incorporate that coordination information into real-time ATC flow management decision-making. New ATC procedures and the operational requirements for the associated technologies will be developed to enable the dynamic coordination of military SUA.

### Program Milestones

Interagency procedures were examined in FY1989 to identify and document the current methods for the FAA/DoD coordination of military SUA. During FY1990, additional discussions between FAA and DoD were conducted to determine the general development direction the agencies should pursue to enhance that coordination process. In FY1991, an effort was initiated to develop an "end-state" concept of a Dynamic Special Use Airspace system that would interface with the DoD SUA scheduling organizations to satisfy the requirements of the FAA's ATC mission. Those ATC requirements are: the timely exchange of military SUA scheduling information and a direct interface with the FAA Traffic Management System.

### Products

- DSUA "end-state" concept document
- Evolutionary stages of DSUA automation functionality
- Interactive TMS/DSUA functionality

## F.2.3 National Airspace System Performance Analysis Capability (NASPAC)

Responsible Division: AOR-100
Contact Person: Arturo Politano, 202/267-7016

### Purpose

*To maintain a long-term analysis capability through the application of modern tools of operations research and computer modeling to develop, design, and manage the nation's airspace on a system-wide level.*

This capability allows analysts to identify limiting factors in national airspace system performance and provides quantitative analyses to determine the impacts of proposed changes on the overall aviation system, while offering useful information to decision makers and strategic planners.

The principal tool used in the project is a simulation model of the entire national airspace system. The model simulates the movement of individual aircraft through the nationwide network of airports, navigation fixes, routes, and sectors. The model incorporates the general structure of the national airspace system as a system of airports, (58 of which are modeled in detail), 106 arrival and departure fixes, and all en route sectors. It also considers en route flow restrictions, the effects of instrument meteorological conditions at airports, and additional details.

### Program Milestones

In FY1990, several analyses were conducted using NASPAC to assess the implications of NAS performance. These analyses included studies of the impacts of a new airline hub, the potential failure of an Area Control Facility, the addition of a new runway to a major airport, and the restructuring of airspace at several Air Route Traffic Control Centers. In addition, enhancements, such as improved airspace routing, aircraft pushback delays, and additional flow restrictions, were made to the model.

Also in FY1990, an initial version of a user-friendly interface to the NASPAC simulation, called "Mini-NASPAC," was completed. This interface will be supplanted in FY1991 by NASPAC Release 1, which incorporates a more complete interface to the NASPAC simulation modeling system.

NASPAC will continue to be improved in FY1991 with the addition of flight cancellations and arrival slot swapping, improved sector loading and aircraft routing algorithms, enhancements to the Future Demand Generator, improvements to the modeling of en route sector capacity and sector delays, and further enhancements to the user interface. A set of standalone tools for simplifying the preparation of model inputs, and a capability to estimate annual delays as well as the cost of delays, will also be developed in FY1991.

Analyses to be performed in FY1991 include an analysis of the nationwide effects of the Precision Runway Monitor and a study of the impacts of Civil Tiltrotor service in the northeast corridor.

In FY1992, the NASPAC simulation modeling system will be enhanced and used to study proposed improvements to the National Airspace System. Improvements will be made to the user interface to make the model easier to use, and improvements will also be made to improve the fidelity of the model and to make it more usable for a broader range of possible applications. The model will be applied to study a broad range of proposed improvements and to study in detail selected proposed system changes.

### Products

- Model documentation and validation
- NASPAC simulation model enhancement
- System impacts of airline hubbing and proposed new airports
- Identification of future congested airspace and airports
- Desktop version of NASPAC
- Weather annualization
- Southern California airspace analysis

## F.2.4 Vertical Flight Operations and Certification

Responsible Division: ARD-30
Contact Person: Steve Fisher, 202/267-8535

### Purpose

*To define aircraft certification standards and explore alternative ATC procedures that will enable the National Airspace System to realize the full potential of vertical flight aircraft.*

### Program Milestones

Economic studies and procedural requirements analysis are needed to determine the most effective integration and expansion by these type aircraft in air taxi, commercial, and air carrier operations. Terminal Instrument Procedures (TERPS) criteria, ATC procedures, and IFR operational standards and aircraft certification requirements tailored to the needs of these aircraft are needed to realize their full potential. In addition, noise prediction and control techniques are needed to ensure their acceptance by the public. A three-phase program has been devised to address these issues.

Phase I includes the analysis of economic, operational, and environmental impacts of advanced rotorcraft and vertical flight aircraft. It also includes the initiation of a comprehensive noise control program.

Phase II includes the assemblage of data needed for TERPS development based upon simulation of tiltrotor aircraft and actual flight data. Noise control efforts will be continued by applying the results obtained in Phase I to real-world applications.

Phase III includes a demonstration phase where the data and criteria developed from the previous phases are applied to various real world scenarios. During this phase, the FAA will be validating the results and findings of earlier efforts. ATC route standards and TERPS criteria will be developed from the data and results obtained.

### Products

- Aircraft training and certification requirements for vertical flight aircraft in air carrier operations category (Part 121)
- Airborne systems definitions for tiltrotor operations; navigation and avionics requirements for tiltrotor TERPS, en route, and transition requirements
- MLS area navigation TERPS for rotorcraft operations; terminal procedures for rotorcraft utilizing MLS approaches
- Revised TERPS for rotorcraft operations using flight directors and coupled approaches
- Proposed ATC procedures for the most effective integration of tiltrotor and helicopter IFR flights into the NAS
- Improved rotorcraft and tiltrotor noise prediction models
- Vertical flight noise abatement and control procedures
- An automated planning tool to allow the FAA and local/urban planners to design the quietest and most effective terminal area operations

### Schedule

- CTR Economics Study .................................... 02/90
- CTR Flight Simulator Study ........................... 06/90
- Pre-TERPS Development Kick-off .................. 12/90
- CTR Missions and Applications ...................... 01/91
- CTR Flight Simulator Study (HUD/Autopilot) ........................................... 04/91
- Rotorcraft Decelerating Approaches ............... 09/91
- Tiltrotor Noise Control Plan .......................... 10/91
- Heavy-Lift Helicopter Approaches Study ....... 06/92
- Tiltrotor (V-22/XV-15) Noise Evaluation Test ............................................ 12/92
- CTR Flight Simulator Performance Analysis ....................................................... 12/92
- Preliminary TERPS Criteria for Tiltrotor IFR Approaches ................................ 12/93
- Draft Rotorcraft IFR Terminal Area ATC Procedures ............................................. 12/94
- Draft Tiltrotor IFR Transition to Terminal Area ATC Procedures ....................... 12/95

# F.3 En Route Capacity Related Projects

## F.3.1 Airspace System Models: Sector Design Analysis Tool (SDAT)

Responsible Division: AOR-100
Contact Person: Ken Geisinger, 202/267-7568

### Purpose

*To develop analytic models, including computer simulations, for evaluating current and future impacts of proposed new National Airspace System (NAS) equipment, air traffic control (ATC) procedural changes, and revised airspace configurations.*

The models will provide quantitative measurements of system performance in terms of safety, capacity, efficiency, and controller workload. This program supports provisions of the Aviation Safety Research Act of 1988, which requires development of models of the ATC system to predict safety and capacity problems. Models developed will emulate the airspace system with a high level of detail and flexibility.

The models will share common elements, but will be tailored for specific ATC needs and users. For example, the first product will be a tool for use by en route airspace designers to evaluate the impact of alternative designs on controller workload. The new product will address terminal airspace. These models will allow analyses of proposed changes in procedures, traffic flow, and airspace design in terms of safety, efficiency, and controller workload. Later products will address the impacts of proposed new NAS equipment and automation on the ATC environment.

### Program Milestones

A prototype sector design analysis tool has been developed. This tool analyzes given traffic flow data and estimates separation assurance workload. Validation and demonstration of the concept was achieved in FY1991. This tool will be expanded to include other controller workload elements in FY1992. This computer-based tool will be implemented at field facilities in FY1993.

### Products

- A computer-based sector design analysis tool capable of being used on ARTCC existing automation equipment by air traffic personnel to assist in resectorization
- Terminal airspace evaluation tool
- ATC automation model
- NAS equipment evaluation model
- Tools for processing, storing, retrieving, and displaying data

## F.3.2 Airspace and Traffic Optimization: Dynamic Ocean Tracking System (DOTS)

Responsible Division: ARD-100
Contact Person: David Ford, 202/267-3534

### Purpose

*To minimize fuel consumption, facilitate aircraft operations for users and the ATC system, and improve ATC designs and procedures.*

*To develop a tool to optimize flight track design and track utilization.*

Computer-efficient algorithms have been developed which determine an aircraft's projected time and fuel consumption over the ocean. Optimization techniques use these algorithms, together with an automatic dynamic weather database and varying ATC separation criteria, to design flexible fuel-efficient tracks for oceanic traffic. A similar process is used to advise individual scheduled flights of the optimal track based on their oceanic entry time and other aircraft traffic they will encounter.

Tests have shown that aircraft flying on a typical trans-Pacific route fly six or eight thousand feet lower than their most efficient altitude. This is due to large separation requirements and the fact that airlines are not able to determine airspace availability. Rough estimates indicate that a DOTS capability will save between 5% and 7% on fuel. Other benefits include reduced controller workload associated with controlling aircraft on structured rather than random track systems designed to flex with changing wind conditions.

With the addition of ADS functionality, the DOTS dynamic wind and temperature data base and track advisory capability will be greatly enhanced. Traffic planners will be able to take advantage of wind and temperature changes to identify fuel-efficient alternative tracks in near real time.

### Program Milestones

In FY1991, track generation programs and traffic management displays were installed in New York, Oakland, and Anchorage ARTCCs. The tests showed that there was a cost benefit to having aircraft fly the generated flight tracks. In addition, DOTS was installed in the Air Traffic System Command Center (Central Flow). The functional application of DOTS in the CONUS will be investigated.

In FY1992, ADS position reporting will be implemented in DOTS, a track advisory system will be installed in New York, Oakland, and Anchorage ARTCCs, and a prototype system will be developed by AOR to demonstrate the functionality of DOTS in CONUS airspace.

### Products

- Algorithms for minimal fuel path generation for any set of position, altitude, velocity, wind, weather, and time constraints
- Prototype hardware and software
- Algorithms and operational guidelines for minimum fuel computations within the oceanic ATC system
- Dynamic simulation model
- Applications

## F.3.3 Oceanic Display and Planning System (ODAPS)

Responsible Division: AAP-310
Contact Person: Richard Simon, 202/267-8341

### Purpose

*To provide an automation infrastructure for oceanic airspace that includes automatic receipt and processing of aircraft position reports, a dynamic flight plan database, an aircraft situation display, and a conflict probe. The system will allow controllers to more effectively utilize oceanic airspace without revising separation standards.*

Oceanic controllers in facilities on the east and west coasts of the United States are confronted with an increasing need for random and direct routes and are not able to visualize these routes from data presented on current flight progress strips or plotting boards. The Oceanic Display and Planning System (ODAPS) will reduce this problem by providing controllers with adequate information to apply separation standards in a timely manner. Requirements validation and design have been completed. Systems have been delivered to both sites, Site Acceptance Tests have been conducted, and ODAPS is operational in Oakland.

### Program Milestones

The contractor has resolved all high and critical priority software problems identified to date. Fifteen NAS Change Proposals (NCPs) have been approved. These NCPs are enhancements to the basic system and are deemed necessary to fully implement ODAPS. The schedule was re-baselined to reflect the impact of these NCPs. Following demonstration of the 15 NCPs, five additional NCPs were identified for full implementation. These five are expected to be implemented by mid-1993.

The ODAPS contract options have been exercised for the New York ARTCC and the FAATC test bed.

### Products

Oceanic display and flight data automation for two ARTCCs

- ZOA S/W handoff to ATR-400 ........................ 07/91
- SYS delivery to last operational site (ZNY) (Package I, II, III & IV) ................................. 07/93
- Last integration test complete (IOC) (ZNY) ...... 09/93
- Last ORD complete (ZNY) ............................... 10/93

## F.3.4 Traffic Management System (TMS)

Responsible Division: ANA-300
Contact Person: Harry B. Kane, 202/267-8336

### Purpose

*To upgrade the present flow control system into an integrated Traffic Management System (TMS) which operates at the national level through the Air Traffic Control System Command Center (ATCSCC) and the local level through traffic management units (TMUs).*

The upgrading of the traffic management system is designed to improve air traffic system efficiency, minimize delays, expand services, and be more responsive to user requirements. The TMS functions include Central Altitude Reservation Function (CARF); Airport Reservation Function (ARF); Emergency Operations Facility (EOF); Central Flow Weather Service Unit (CFWSU); various flow management programs with integrated metering functions such as the Departure Sequencing Program (DSP), En route Spacing Program (ESP), and the Arrival Sequencing Program (ASP); and Enhanced TMS (ETMS) functions including the Aircraft Situation Display (ASD) and Monitor Alert (MA).

### Program Milestones

Phase I of the TMS program has been completed. It replaced outdated computer systems, implemented a data communications system to interface users and ARTCC computers in a two-way data mode interfacility flow control network (IFCN), and relocated CARF and the automation staff to FAA headquarters.

Phase II has provided the Enhanced Traffic Management System, which is a computer network that implements the aircraft situation display (ASD) and monitor alert (MA) functions developed by the Advanced Traffic Management System (ATMS) research and development program, for the Air Traffic Control System Command Center (ATCSCC), all Air Route Traffic Control Centers (ARTCCs), and several Terminal Radar Approach Control Centers (TRACONs). New computer systems with color graphics workstations have also been provided to the ATCSCC, TMUs, and the FAA Technical Center, which interface with the Traffic Management Computer Complex (TMCC), the host computers, and the ETMS computers to provide enhanced information displays and near real-time flight data. The Arrival Sequencing Program (ASP) and En Route Spacing Program (ESP) Package 1 metering enhancements to the host computers have also been provided.

Continuing Phase II activities are focused on replacing the TMCC, completing implementation of ASD and MA functions in all en route centers, implementing ASP and ESP Package 2 on the Host computer, and providing standalone monitors in the ATCSCC and the TMUs to display weather products.

Follow-on activities to Phase II will include providing automation equipment to non-en route facilities, relocating the ETMS computers from the development location to an FAA facility, providing an enhanced high data rate interface between the Host and ETMS computers, integrating DSP into the TMS and providing meter list display devices for the ARTCCs. Other activities will include implementing ATMS functions on the ETMS, providing TMS hardware and software in the Advanced Automation System time frame until the next generation TMS becomes operational, and improving traffic management performance analysis capabilities by developing standards, procedures, and tools to facilitate the accurate reporting, collection, and analysis of NAS data.

### Products

- One Air Traffic Control Command Center, comprised of a CFCF, CARF, ARF, CFWSU and a central altitude reservations function. The TMS computer complex is located at the FAATC. ETMS computers are currently located at Transportation Systems Center, Cambridge, Mass.
- One computer program suitable for adaptation and use at 20 domestic ARTCCs and selected TRACONs.

## F.3.5 LORAN-C Systems

Responsible Division: AND-30
Contact Person: Richard Arnold, 202/267-8709

### Purpose

*To conduct necessary procurement and implementation projects to meet FAA responsibilities for the use of LORAN-C in the NAS.*

LORAN-C is the government's navigation aid for coastal areas of the United States, including southwestern Alaska and Hawaii. Signal coverage was increased in 1991 over the mid-continent area and now all 48 contiguous states have LORAN-C service. Low-cost avionics have made LORAN-C an attractive area navigation aid for general aviation; it has been approved for en route and non-precision approach use under instrument conditions. One goal remains: to bring LORAN-C into maximum use in the NAS as a supplemental aid by completion of the installation of signal monitors to support non-precision approaches throughout the NAS. The signal monitors will provide the seasonal time difference correction information required to accurately perform a non-precision approach.

### Program Milestones

Two new LORAN-C chains of stations were completed in the U.S. mid-continent in April 1991. LORAN-C monitor units consist of two parts: monitors and interface electronics to VOR equipment. Signal monitors were installed at 196 sites. Installation will be completed in 1992 when interface electronics are placed in the host facilities.

### Products

- LORAN-C Signal Monitor System
- LORAN-C mid-continent transmitters

## F.3.6 Automatic Dependent Surveillance

Responsible Division: ARD-100
Contact Person: Peter Massoglia, 202/267-9845

### Purpose

*To support the development and implementation of an automatic dependent surveillance (ADS) function to improve safety and provide economic benefits to users of oceanic airspace, as well as to aid oceanic controllers in effectively controlling oceanic airspace, with evolutionary applications to domestic airspace.*

The ADS function will provide for improvement in tactical and strategic control of aircraft. Automated processing and analysis of frequent position reports will result in nearly real-time monitoring of aircraft movement. The capability of ADS to provide timely and high-integrity aircraft position data via a satellite air/ground data link will permit possible reduction in separation standards, as well as increased accommodation of user-preferred routes and trajectories.

The program will be developed in incremental steps, with the first step being the ADS capability. The second step will add two-way digital data communications for air traffic command and control. Follow-on steps will add additional features, including digital voice, all leading to safer and more efficient use of the airspace.

### Program Milestones

Implementation of ADS will be at the Oakland and New York Centers only. Step 1 is scheduled for 1993 and Step 2 for 1995.

### Products

- ADS Step 1 mod operational on Oceanic Development Facility (ODF)
- Perform Pre-Operational Trials
- Complete Step 2 Requirements Definition
- ADS Step 1 installed at Oakland and New York
- Complete Step 2 Operational Concepts and System Specification
- ADS Step 2 mod operational on ODF
- Complete display enhancements to ADS
- Complete integration and validation of Step 2 mod on ODF
- Complete avionics development support
- ADS Step 2 installed at Oakland and New York
- Complete advanced satellite tests
- Commence ADS integration into AAS
- Complete Laboratory and Flight Test

## F.3.7 En Route Separation Standards

Responsible Division: ASE-300
Contact Person: Jerry W. Bradley, 202/646-4824

### Purpose

*To provide quantitative guidance for domestic and international decision-making concerning adequate minimum safe horizontal and vertical separation standards.*

Quantitative guidance based on statistical analysis is provided to support decision-making to reduce vertical and horizontal (lateral and longitudinal) separation requirements. This activity consists of model development, data collection, data reduction, and analysis. It also includes: (1) the investigation of the effect on separation standards of imposing tighter required navigational performance specifications, (2) determinations of the effect of tolerating mixtures in the total aircraft population of both old and new specifications, and (3) investigations of the potential for the safe improvement of separation requirements in a system with advanced future navigation systems. These analyses include considerations of the role of pilot and controller and their feedback loop process in evaluating navigational performance within the framework of collision risk methodology. This program also provides support in developing and establishing methods and procedures for monitoring standards compliance and safety.

This effort will also help establish separation requirements based on Automatic Dependent Surveillance (ADS), Area Navigation (RNAV), and other developing technologies for supporting reduced permissible separation minima.

The oceanic horizontal separation standards program will analyze separation standards in the North Atlantic, West Atlantic, Central East Pacific, and North Pacific route systems. It will examine the impact of various system improvements on safe minimal horizontal and longitudinal spacings for oceanic traffic. As oceanic control becomes increasingly flexible through automation, this program will establish appropriate separation standards to facilitate maximum traffic efficiency and safety.

Onboard, time-based navigation capabilities and associated ATC capabilities will be analyzed in an effort to study the feasibility of time-based separation standards.

The vertical separation program will determine the practical feasibility of reducing the vertical separation minimum between FL 290 and FL 410 from 2,000 to 1,000 feet, thus adding six additional flight levels in this altitude range. This change would provide the ATC system with enhanced flexibility to accommodate user-preferred flight profiles and would lead to substantial savings in user fuel costs.

### Program Milestones

In FY1990, the development of a data package to support rulemaking on the vertical separation standards change in U.S. domestic airspace from 2,000 to 1,000 feet above FL290 was completed. In addition, ICAO guidance material was finalized. The investigation of system performance monitoring techniques was begun in FY1991 and is continuing through FY1992.

In FY1990, material for worldwide RNAV procedures was completed and submitted to ICAO. This information was combined with that from other countries and integrated with the Required Navigation Performance Capability (RNPC) concept for review during FY1995 and 1996. This effort supported the ICAO Review of General Concepts of Separation Panel (RGCSP), North Atlantic Special Planning Group (NATSPG), and other special groups. This support will continue in FY1991 and 1992.

In FY1989, an effort was initiated to develop revised oceanic separation standards based on ADS. In FY1990, a data collection plan was developed and coordinated with the airline community. As aircraft are equipped with ADS, data will be collected.

### Products

Horizontal Separation Standards

- Reports on the feasibility of reduced horizontal separation in oceanic airspace
- Reports on simulation and test results for reduced horizontal oceanic separations
- Data packages for international coordination of horizontal oceanic separation standards

Vertical Separation Standards

- Data analysis and operational tests and evaluation of reduced vertical separation
- Recommendations for rulemaking on vertical separation standards
- Input to ICAO documents
- NASP Group to implement 1,000 ft. vertical separation standards in 1997. This will be the first time it will be used in flight levels above 290.

## F.3.8 Advanced Traffic Management System (ATMS)

Responsible Division: ARD-100
Contact Person: Stephen M. Alvania, 202/267-3078

### Purpose

*To reduce delays and enhance operating efficiencies through a highly automated traffic management system.*

The ATMS program is the FAA research and development effort in direct support of the operational Enhanced Traffic Management System (ETMS). The ATMS is used to investigate automation and technology applications that will enhance the operational capabilities of the FAA Traffic Management System. The ATMS program is structured as the development of a sequence of evolutionary flow management capabilities which, once determined to be operationally beneficial, migrate to the operational ETMS system through a common development/testbed facility. The ATMS evolutionary stages currently defined are: Aircraft Situation Display (ASD) to monitor the NAS in "near real time;" Monitor Alert (MA) to automatically alert flow managers to projected congestion and delay conditions; Automated Demand Resolution (ADR) to generate alternative flow management strategies that deal with the projected conditions; Strategy Evaluation (SE) to provide real-time analytical support to the flow management decision-making process; and Automated Execution (AEX) to automatically distribute facility-specific flow management directives that will implement the selected strategy.

### Program Milestones

The Aircraft Situation Display (ASD) and Monitor Alert (MA) functions are currently being deployed as part of the operational ETMS at the Air Traffic Control System Command Center (ATCSCC), all ARTCCs, and selected TRACONs.

Prototype Automated Demand Resolution (ADR) algorithms are being designed and incorporated into the ATMS testbed for evaluation. During FY1991 and FY1992, these algorithms will be tested and refined. Migration to the ETMS is expected in FY1993.

The development of the Strategy Evaluation (SE) function will begin in FY1993 with migration to the ETMS anticipated in FY1994.

The Automated Execution (AEX) function will be significantly more sophisticated than the previous stages. Development of this function is expected to commence in FY1994, with migration to the ETMS currently scheduled for FY1998.

### Products

- Prototype Aircraft Situation Display (ASD) functionality
- Prototype Monitor Alert (MA) functionality
- Prototype Automated Demand Resolution (ADR) functionality
- Prototype Strategy Evaluation (SE) functionality
- Prototype Automated Execution (AEX) functionality

## F.3.9 Automated En Route ATC

Responsible Division: ARD-100
Contact Person: Vern Edwards, 202/267-9851

### Purpose

*To provide evolving improvements in capacity and safety in the en route and/or positive control airspace (PCA) through the integration and enhanced automation of various air traffic functions.*

*To improve capacity by better accommodating individual user objectives through direct user involvement inflight planning and the integration of onboard flight management systems (FMS) with ATC computers.*

*To improve capacity by improving airspace efficiency/ throughput by use of more airspace and facilitate the use of direct routing.*

*To improve safety through the reduction of operational errors.*

Automated En Route Air Traffic Control (AERA) is a continuing program that involves the evolution of the en route system to higher levels of automation and sophistication. The program is structured in two parts — implementation (AERA Services) and research and development (Advanced AERA Concepts). The implementation part of AERA introduces an introductory set of automation capabilities in the form of automation aids that will support air traffic personnel in the detection and resolution of problems along an aircraft's flight path, and in the planning of traffic flows. AERA Services combine what was initially known as AERA 1 and AERA 2 and may involve some of the functionality currently undergoing research and development by the time it becomes operational. These introductory AERA Services also set the stage for evolution to higher levels of automation which is currently under investigation in Advanced AERA Concepts (AAC).

Currently, AAC is involved in research and development activities related to functionality envisioned for the most highly automated phase of the AERA program to date. The essence of the AAC activities is to develop, evaluate, and validate operationally and technically the capability and suitability of automating the aircraft separation assurance function and much of the local flow management functions into a more highly automated and integrated system. The human will maintain a presence, albeit at a different level, where he becomes a supervisor of the automation rather than reactive to the automation. The air traffic control system of today will become the air traffic management system of tomorrow.

### Program Milestones

Laboratory facilities for AERA Services were established in 1987. This laboratory has been used for prototyping and analyses of AERA Services' functionality to refine and/or revise operational and specification requirements, as well as associated supporting technical documentation. These algorithmic and performance specifications and candidate ATC procedures were completed in 1991.

In the next phase of AERA Services portion of AERA, that software will be developed and undergo an operational evaluation at the FAA Technical Center. This software and the ATC procedures will be updated as a result of the operational evaluation. This operational evaluation phase has already begun and is scheduled to continue through 1997.

AAC functionality is scheduled to be completed in five (5) Builds in a research and development prototype environment called the "ProtoCenter." In 1989, Build 1.0 of preliminary components Advanced AERA Services functionality was completed at the ProtoCenter. Build 1.0 integrated several standalone R&D prototype functions and successfully separated aircraft, using actual behind-the-panel algorithms in lieu of simulation, in realistic simulation scenarios consisting of over 100 aircraft.

In 1990, work continued on the integration, refinement, and problem corrections arising from Build 1.0 demonstration/evaluation. Additionally, functionality was incorporated into the ProtoCenter in preparation for Build 2.0. A metering function was included so that functionality would not only keep aircraft separated but would also develop time schedules and general schedules to ensure that aircraft meet assigned time constraints (e.g., metering into terminal areas).

In 1991, the Build 2.0 demonstration/evaluation was completed with positive results. Build 2.0 functionality was run against data from the Denver ARTCC at today's traffic levels. The ProtoCenter was augmented with a set of functions to cope with data uncertainties, in a deterministic manner, resulting from imperfect knowledge of winds aloft and aircraft speed. Work also continued in a parallel effort to develop the revised human role in a more highly automated system and determine how the data should be presented for human comprehension. These human computer interface requirements will be incorporated into the ProtoCenter over the next several years.

*CONTINUED ⇒*

## Products

- AERA Services:

  Specification and perfomance requirement being incorporated into the AAS. Operational availability of functionality scheduled around 1998.

  Enhancement package to functionality resulting from FAA Technical Center operational evaluation or enhancement packages from Advanced AERA Concepts.

- Advanced AERA Concepts:

  Technical Data Package (TDP) defining functionality for implementation. This will include specifications, changes required to baseline NAS documents, performance and interface requirements, and other supporting documentation.

  Spin-offs for early implementation. For example, early implementation (1994) of Airspace Manager function as part of TMU in centers as a standalone system.

  Supporting analyses and technical documentation.

# F.3.10 Operational Traffic Flow Planning

Responsible Division: AOR-200
Contact Person: Robert Rovinsky, 202/267-9952

## Purpose

*To provide dynamic, fast-time automated traffic planning and decision support tools which (1) plan daily air traffic flow based on user schedules, aircraft performance, weather, and other operational situations; (2) develop traffic plans for joint FAA/user planning and decision-making; (3) predict traffic problems and probable delay locations; and (4) generate routes and corresponding traffic flow strategies that minimize fuel and time for scheduled traffic.*

A coordinated system of interactive computer models and decision support tools are being developed through rapid prototyping. The development program capitalizes upon proven technology such as the Dynamic Ocean Tracking System (DOTS) and will extend this technology to the domestic U.S. airspace. Other prototyping efforts will be based on previously developed optimization and simulation technology.

## Program Milestones

In FY1991, the High Altitude Route System (HARS) program will complete development and evaluation of a test-bed prototype. In FY1992, the prototype will be used as the "core" of the initial operational HARS planning model for field implementation at the ATCSCC and TMUs. The HARS initial prototype will provide functional software for optimized track generation and traffic flow planning for major U.S. city pairs. HARS will also include an alternate flow generation function (FLOWALTS) that provides rapid analysis of alternate route and flow strategies. HARS field prototype development and demonstration will begin in FY1993, and will provide both follow-on enhancements enabling full track generation and traffic optimization for high altitude traffic anywhere in the U.S. and integration with oceanic traffic management systems.

In FY1991, work on a fast-time simulation model for traffic flow planning (FLOWSIM) will help the FAA plan daily air traffic flow based on user schedules, aircraft performance, weather, and other operational situations; predict traffic problems and probable delay locations; and facilitate joint FAA/user planning and decision-making. Development of a consolidated U.S. airspace data model will also begin in FY1992 and will demonstrate and test an initial prototype in FY1993. Finally, the development of a National Airspace System model, which will provide the capability for detailed prediction and simulation of daily traffic and flow strategies, will also begin in late FY1992. It will utilize and integrate many of the technologies and tools developed in the preceding projects (e.g., HARS, FLOWSIM, FLOWALTS, DOTS, etc.).

### Products

- Algorithms and models for optimized, fuel-efficient high altitude routes
- Algorithms and models for developing optimum departure and arrival sequencing plans
- Fast-time simulation of traffic flow plans
- Algorithms to generate alternate traffic flow strategies by computer ranking fuel and time impacts
- An integrated U.S. airspace data model for detailed national simulation
- Detailed prediction and simulation of daily traffic

## F.3.11 ATC Automation Bridge Development: TRACON Re-code, Display Channel Re-host, and Full Digital ARTS Displays

Responsible Division: ARD-20
Contact Person: Royce Wilkerson, 202/267-7547

### Purpose

*To develop a TRACON replacement system and an en route display channel replacement system.*

Advanced Automation System (AAS) end-state equipment will be used in this system where technically feasible. The minimum functional capability of this new system will be equivalent to the current system. Capacity and display capabilities will be increased to allow for future growth.

### Program Milestones

Alternative design approaches will be identified in FY1991. Detailed designs will be completed in FY1992. Risk mitigation demonstrations will be conducted in FY1993.

### Products

- Design alternatives for TRACON systems and en route display channel systems

## F.3.12 Ground Delay Substitution Analysis

Responsible Division: AOR-200
Contact Person: Robert Rovinsky, 202/267-9952

### Purpose

*To provide FAA's Air Traffic Management Service with a set of strategies to follow to improve the ground delay substitution process.*

### Program Milestones and Products

A report on the ground delay substitution system to help air traffic management establish policies and operational options is planned for the beginning of FY1992.

## F.3.13 Meteorologist Weather Processor (MWP)

Responsible Division: ANW-300
Contact Person: Donald Stadtler, 202/267-5857

### Purpose

*To implement a system that provides for the processing of alphanumeric and graphic weather products received from the National Weather Service (NWS) and radar and satellite imagery.*

The MWP will support the delivery of improved services by the Center Weather Service Units (CWSUs) at Air Route Traffic Control Centers (ARTCCs) and the Central Flow Weather Service Unit (CFWSU) at the Air Traffic Control System Command Center (ATCSCC).

### Program Milestones

The MWP system has been delivered to the first operational site, the Atlanta ARTCC. The current deployment schedule will have MWP delivered to all ARTCCs by the end of November 1991.

### Products

- MWP systems, including an interactive workstation for the CWSU/CFWSU and briefing terminals for air traffic personnel to display alphanumeric, graphic, radar, and satellite weather products.

## F.3.14 Aviation Weather System

Responsible Division: ARD-220
Contact Person: Arthur Hansen, 202/267-9743

### Purpose

*To improve the analysis and forecasting of weather that affects the safety, capacity, and efficiency of the National Airspace.*

*To develop sensors for the collection and analysis of meteorological data from both airborne and ground operations.*

*To develop training programs to improve aviation weather services.*

*To develop and demonstrate, in an operational environment, airborne detection and warning technology leading to reduced risks associated with severe windshear conditions.*

*To provide weather services that will reduce the weather information handling workload of air traffic controllers.*

### Program Milestones

High resolution upper wind and temperature analyses and forecasts will be provided operationally every 3 hours beginning in 1992.

In FY1991, the development of the flight crew and ground-system flight procedures will be developed to support the flight test activities in FY1992. The first flight tests of combined radar, lidar, infrared, and windshear data communications will take place in the summer of FY1992 and be completed in FY1993.

### Products

- Sensors to measure humidity, visibility, and temperature icing aboard air carriers
- Mesoscale numerical prediction models, data assimilation, nowcasting methods, and model evaluation for analysis and forecasting of aviation weather parameters
- Experimental forecast center for testing and evaluating new products and methods
- Enhanced terminal weather products (e.g., hazardous storm cell detection)
- New local area nowcasts and short-range forecasting techniques using statistical techniques and expert systems
- Algorithms to quantify the hazard from windshear data communications
- Modules for computer-aided training in aviation weather
- Advanced airborne windshear sensors for integration into the flight deck

## F.3.15 Aeronautical Data Link

Responsible Division: ARD-300
Contact Person: Ron Jones, 202/267-8655

### Purpose

*To develop aeronautical data link communications standards to support use requirements for satellites, Mode S, and VHF.*

*To develop and implement ATC and non-ATC data link applications.*

### Program Milestones

A draft advisory circular has been published and distributed to industry for comment. Planned for FY1991 is the operational deployment of pre-departure clearance at 30 airports. A Data Link Processor (DLP) was delivered to the first operational site in FY1991. The first operational use of DLP will be a DLP weather database available via Mode S, scheduled for early FY1993. A prototype digital ATIS service using a tower data link system will be evaluated in FY1991 with deployment of the operational ATIS service in FY1995. Development of DLP Build-2 enhancements to support added communications functionality and additional data link services began in FY1991 with operational deployment planned for FY1996. Initial en route and terminal ATC services are being developed with implementation planned in the FY1996-1998 timeframe.

### Products

- Communications standards (RTCA, ICAO, AEEC, etc.)
- Data Link Processor that supports a weather database for pilot access (Build-1 and support for the Aeronautical Telecommunications Network Build-2)
- Tower datalink system to support Pre-Departure Clearance delivery and other tower applications
- Specifications for ATC and non-ATC data link applications (e.g., Automated Terminal Information System, wind shear alerts, hazardous weather information, traffic information, and en route and terminal automation)
- FAA Advisory Circular for airworthiness approval of data link systems

## F.3.16 Satellite Navigation

Responsible Division: ARD-300
Contact Person: Joe Dorfler, 202/267-8463

### Purpose

*To develop augmentation(s) and verify the use of satellite navigation systems such as the Global Positioning System (GPS) for civil aviation in order to obtain the capacity and flexibility benefits of a space-based navigation system that will be available for use in NAS for en route, terminal, departure, non-precision and precision approaches, and airport surface guidance everywhere.*

### Program Milestones

In FY1991, Minimum Operational Performance Standards (MOPS) for GPS avionics will be developed to support GPS use as a navigation supplement. This will enable a Technical Standards Order (TSO) to be developed for certification of avionics and will enable Flight Standards to develop an FAA Advisory Circular authorizing operational use of GPS. In FY1992, requirements for augmentation to GPS to support its use as a sole-means navigation source will be developed. MOPS for use of GPS and GPS hybrids for use as a sole-means navigation source will be developed starting in FY1993. In FY1995, MOPS for integrated GPS/GLONASS will also be developed to support their use for en route navigation. Starting in FY1994, modifications to MOPS for avionics to support non-precision instrument approaches will be developed. A study and verification of the feasibility of the use of GPS for precision approaches will then proceed and is planned for completion in FY1997.

### Products

- Performance standards for aircraft avionics
- GPS system performance specifications
- Requirements for augmenting GPS for use as sole-means navigation, non-precision, and (potentially) precision approaches

# F.4 Airport Capacity Related Projects

## F.4.1 Airport Capacity Design Team Studies

Responsible Division: ASC-100
Contact Person: James McMahon, 202/267-7425

### Purpose

*To establish a forum, sponsored and supported by the FAA, in which airport management, the local FAA, airlines, commuters, industry groups, and airport planning consultants work together to develop technically feasible alternatives for improving airport capacity and reducing delay.*

Design team studies have been established at airports where the need for capacity improvement is identified. The studies typically investigate application of new air traffic control procedures, navigation aids, system installations, airport development, and other prospective capacity improvements. Alternatives are then evaluated using state-of-the-art simulations. The simulations provide a measure of benefit in terms of hours of delay reduction and allow the FAA to refine modeling techniques while gaining operational benefits through assistance to the design team studies.

### Program Milestones

During FY1991, design team efforts were successfully completed in Salt Lake City, Washington-Dulles, Seattle, Orlando, Chicago, Nashville, Raleigh-Durham, Charlotte, and Los Angeles. Design team studies still underway include Pittsburgh, Philadelphia, San Juan, San Antonio, New Orleans, Honolulu, Ft. Lauderdale, Houston, Cincinnati, and Cleveland. Among the airports being considered for design team studies in 1992 are Port Columbus, Indianapolis, Bradley, Dayton, and Las Vegas. New runways are being planned at Atlanta, Detroit, Kansas City, Orlando, Phoenix, St. Louis, and Washington-Dulles as a direct result of airport capacity design team efforts.

Completed design team studies resulted in over 270 recommendations in FY1990-91, 76 of which have already been implemented. Another 76 recommendations are either in the planning phase or the environmental assessment phase. Over 500 proposals for enhancing capacity have been developed for analysis by the design teams since the program began in 1985.

### Products

- Action plans incorporating the projects and programs that produce capacity improvements and delay reductions at airports under study
- Analysis of airport capacity

## F.4.2 Aviation System Capacity Planning

Responsible Division: ASC-100
Contact Person: James McMahon, 202/267-7425

### Purpose

*To develop a capacity plan that meets forecasted increases in aircraft operations and allows aircraft to move safely through the airport and airspace environment.*

Aviation System Capacity Planning is made up of airport design, airspace design, and approach procedures. Airport capacity design teams, currently on-site at 12 airports, are made up of airport operators, the FAA, airlines, and other users. The team starts with a simulation of the current airport and adjacent airspace environment using actual operating data to establish a baseline. The team then develops a list of potential improvements to increase capacity and, using a variety of simulation and queuing models, tests their effect in the specific airport environment. Among the improvements investigated are airfield improvements, such as new runways and runway extensions; improved approach procedures, such as reduced longitudinal separations; new facilities and equipment, such as the Microwave Landing System (MLS); and user improvements, such as relocating a portion of the general aviation traffic to a nearby reliever airport. Those improvements found to produce the greatest capacity increases, together with the estimated delay reduction and cost-saving benefits of each, are integrated in the final report. Residual delay, after all enhancements are implemented, creates requirements for additional research and development into new capacity-enhancing approaches.

To provide for the projected increases in traffic and the implementation of the airport capacity design team recommendations, the airspace structure is redesigned and the traffic flows are modified to accommodate more aircraft and ease the burden on control facilities. Airspace redesign begins with the simulation of the airway environment of the air traffic control center. Actual operational data is used to establish a baseline. The airspace design team then develops alternatives such as more direct routing, segregating jet, turboprop, and prop traffic, and relocating cornerpost navigational aids to allow for more arrival and departure routes. These alternatives are simulated to determine their effect on delay, travel time, sector loading, and aircraft operating cost. The most successful alternatives are incorporated into a plan to redesign the airspace for increased capacity and efficiency. Ultimately, all 20 centers, encompassing the whole U.S. airspace system, will be included in the baseline run, making it possible to accurately evaluate the effect of a specific airspace redesign project on the entire system.

Terminal approach procedures are designed to increase the number of arrivals in poor weather. In most cases these are multiple approach procedures aimed at allowing the simultaneous, or near-simultaneous use of more than one arrival runway. Implementation of many of these procedures is dependent on the use of new technology such as the Precision Runway Monitor (PRM) and the Converging Runway Display Aid (CRDA).

### Program Milestones

In CY1991, the 1991-92 Aviation System Capacity Plan will be produced, analyzing the benefits of new airport development, airspace changes, progress on implementing improved airspace procedures, and new technology to support airport, airspace, and procedures improvements. In addition, final reports of the airport capacity design teams at Chicago/O'Hare, Seattle, Charlotte, Salt Lake, Pittsburgh, Raleigh-Durham, Nashville, Los Angeles, Philadelphia, and San Juan will be issued. Airspace design teams are scheduled to complete reports for the Washington and Cleveland centers and to begin work on New York (Phase II), Oakland, and Miami/San Juan.

### Products

- Aviation System Capacity Plans
- Airport Capacity Design Team Reports
- Airspace Analysis Technical Reports
- Approach Procedure Improvement Reports

## F.4.3 Terminal/Landside Traffic Modeling

Responsible Division: APP-400
Contact Person: Larry Kiernan, 202/267-3451

### Purpose

*To develop a microcomputer-based process for designing airport terminal buildings for functional efficiency and to alleviate congestion.*

There is a significant need to improve and enhance the capacity of airports on the airside, ground side, and in terminal areas, as well as the combined capacity of all these components. Some airports have efficient airside designs and poor terminal designs, while others have better terminal designs than airside. For any airport to operate efficiently, these elements need to be planned and constructed in combination, as an integral design solution. The FAA is developing standard computer simulations which can be used to evaluate airport terminal design. These standardized, readily accessible programs will be useful tools for architects, engineers, and planners involved in terminal design and expansion. Simulations also will aid airport operators in evaluating terminal improvement options and planning for expansion.

This program will develop a series of models for use in planning airport passenger terminals and ground access. These models will analyze pedestrian flow through terminals and related areas as an aid in estimating space and access requirements. Commercial software will be evaluated to determine whether it meets agency requirements. Modifications or new software may then be developed.

### Program Milestones

During FY1989 and 1990, several existing terminal models were reviewed and analyzed. Based on the results of the review, an expert group was convened to establish operating characteristics of a standard terminal design model.

Research is underway on the means by which passengers arrive at the airport and the ability of the ground access system to handle that demand. In addition, there is ongoing research on the interface between mass transit and air/ground transportation.

An advisory circular containing computer-aided design tools will be developed to guide architects, engineers, and planners in airport terminal and ground access design.

### Products

- Public-domain microcomputer software
- User manuals
- Advisory circular on Computer-Aided Design

## F.4.4 Supplemental Landing System (ILS)

Responsible Division: ANN-200
Contact Person: Gary Skillicorn, 202/267-6675

### Purpose

*To establish new, partial, and full ILSs, and upgrade existing ILS facilities.*

Runways qualifying for new ILSs in all categories will result from new airport construction and the need for increased landing capacity at existing airports. These new systems will provide precision approach guidance for new installations until the transition to MLS. Some of the older systems have been in service for nearly two decades. These systems are experiencing severe logistics support problems because spare parts are not readily available and maintenance costs are up sharply. The systems being replaced are AN/GRN-27 ILS, Wilcox CAT II/III ILS, and Mark 1A, 1B, and 1C ILS.

Production of AN/GRN-27 equipment ceased in 1976. As such, parts are no longer available. Maintenance costs are up because parts must be custom manufactured or refurbished to restore failed systems and subassemblies.

Wilcox CAT II/III ILS systems will be replaced to prevent severe logistics support problems and to maintain the integrity and reliability of these facilities.

Mark 1A, 1B, and 1C ILS systems are nearing the end of their life cycles and must be replaced.

### Products

- Replacement of equipment will incorporate remote maintenance monitoring capabilities and require only minimal manual intervention. Work is ongoing to install 79 CAT I ILSs at identified locations. An additional 200 CAT I ILSs will be installed over the next 10 years. Over the next ten years, 50 partial ILSs will be installed.
- 120 existing localizer-only facilities will be upgraded to full ILS status through the acquisition of glide slopes and middle marker beacons. Approximately 50 existing CAT I ILSs will be upgraded to CAT II or CAT III ILSs to meet the needs of expanding airports.
- 25 CAT II/III ILS systems through Wilcox CAT II/III ILS replacement
- 75 AN/GRN-27 ILS replacement systems
- 180 CAT I Mark 1A, 1B, 1C replacement systems

## F.4.5 New Denver Airport

Responsible Division: ANS-300
Contact Person: Jerry Champion, 202/267-7333

### Purpose

*To build a major new international airport to replace Stapleton.*

This project provides for the establishment of new and the modernization/relocation of existing systems, facilities, and equipment to support the operation of the new airport. The new airport will allow for increased capacity and efficiency of aircraft operations to support the growing needs of the air transportation system.

Denver currently ranks seventh in the nation in volume (enplanements and operations) of aircraft. Based upon forecasted growth over the next 10 years, the airport will reach saturation, and delays will be unacceptable during the peak traffic periods. During adverse weather conditions, the acceptable operations rate at Stapleton is reduced to approximately one-half the rates attainable during visual procedures. Completion of the new Denver airport will increase arrival capacity from 38 to more than 90 arrivals per hour in adverse weather conditions. This will reduce delays at Denver and throughout the NAS.

### Program Milestones

The new Denver airport is scheduled to open with five 12,000 ft. runways and a commuter runway in the fall of 1993, with an additional jet transport runway completed by the end of the next construction season (fall of 1994). The new airport has the largest land area (34,000 acres) of any airport in the United States. The runways are far enough apart to conduct triple simultaneous independent approaches in IFR weather. In addition, the design of the airfield is such that aircraft will be able to taxi to and from the terminals without crossing an active runway. This will reduce the possibility of runway incursions. The airfield has been designed to allow flow-through dual taxiways between each concourse. The airport has been built on such a large area that aircraft are unobstructed by push-back conflicts and no noise restrictions are in place.

The reliever airport for the new Denver airport is Front Range Airport, located three miles away. This airport is more attractive to business jets and general aviation. The runways at Front Range all line up in the same direction with those at Denver so they do not interfere with Denver traffic. In addition, there will be a satellite tower for Denver located at Front Range.

### Products

- FAA facilities and equipment to meet the navigation and operation requirements of the new Denver International Airport.

## F.4.6 Low-Level Wind Shear Alert System (LLWAS)

Responsible Division: ANW-400
Contact Person: Steve Hodges, 202/267-7849

### Purpose

*To monitor winds in the terminal area and alert the pilot, through the air traffic controller, when hazardous windshear conditions are detected. Windshear conditions occurring at low altitude in the terminal area are hazardous to aircraft encountering them during takeoff or final approach.*

### Program Milestones

The LLWAS program was initiated in early 1975. Among the sensors evaluated were pressure jump detectors, pulsed and CW Lasers, acoustic Doppler systems, pulsed Doppler radar and arrays of anemometers. The last technique was selected as the most cost-effective approach. Doppler radar promised the best capability at the time, but the technology was not sufficiently mature and the cost and technical risks were high. Full-scale development began in 1976, resulting in the evaluation of LLWAS at six airports. Production was initiated in 1978 and, of the 110 airports that were designated to receive the system, to date, 110 LLWAS units are now operating.

The program to upgrade the systems began in 1985 and contracts were awarded in 1987. The upgrade provided new processors and significantly improved the algorithm which increased the probability of detection and reduced the false alarm rate. This program was completed in the spring of 1991.

The LLWAS Expanded Network upgrade will provide additional sensors for microburst detection and identification. It will provide new displays for controllers and provide runway oriented wind shear information. The new upgrade has been tested at Denver and New Orleans and has been highly praised by pilots and controllers. The system saved a passenger aircraft in 1989. The competitive RFP to completely retrofit all 110 systems will be issued in 1992. The new system will have tall poles, new hardware and software, ice-free sensors and will interface with Terminal Weather Doppler Radar (TWDR) and will be equipped with a high reliability integrated sensor package.

### Products

- One hundred and ten production systems, including spares, training, and documentation.

## F.4.7 VORTAC Program

Responsible Division: ANN-130
Contact Person: Don Shaklee, 202/267-6661

### Purpose

*To form a modern cost-effective national navigation network which provides required coverage through the replacement, relocation, conversion, and establishment of VORTAC, VOR/DME, and VHF Omnidirectional Range Test (VOT).*

Very High Frequency Omnidirectional Ranges (VOR) with Distance Measuring Equipment (DME) or Tactical Air Navigation (TACAN) are en route air navigational and approach aids used by pilots to conduct safe and efficient flights and landings.

From FY1982 through FY1989, the FAA replaced 950 vacuum tube-type VOR and VORTAC systems with modern solid-state equipment. New Remote Maintenance Monitoring compatible DME systems will replace existing DME systems at 40 VOR/DME sites. The units removed from these sites will be redeployed to ILS sites. 77 tube-type VOTs will be replaced with solid-state equipment, and 35 new VOT systems will be established. VOR/DME facilities are being relocated to accommodate route structure changes, real estate considerations, and site suitability. Conventional VORs are being converted to Doppler VORs to solve siting problems and to obtain required signal coverage. Operational requirements that arise in various geographic areas require the establishment of VHF navigational aid services. Provisions have been made to establish 70 VOR/DME sites including new VOR/DME equipment at non-Federal takeover locations. DME systems will be added at 47 sites equipped with VOR only.

### Program Milestones

All vacuum tube-type VOR and VORTAC equipment has been replaced with solid-state equipment which has embedded remote monitoring and control capabilities. DME service will be provided at all VOR facilities. A network plan has been developed to redistribute VORs to meet operational requirements. Tube-type VOT equipment will be replaced with solid-state equipment. VOR/DME and VOT sites will be established to meet operational requirements.

In FY1990, the VOR/DME contract was awarded, the VOR/DME system design review was completed, and the design qualification test for VOT was completed.

### Products

- To date, 725 VORTACs, 145 VOR/DMEs, and 80 VOR's have been replaced, 15 VORs have been converted to Double Sideband (DSB) DVOR, 50 DVORs have been retrofitted with RMM and DSB, 35 VOTs have been established, and 77 VOTs have been replaced.
- In the next ten years, the FAA plans to establish 70 VOR/DMEs, establish 40 DMEs at VORs, replace 47 DMEs at VORs, reinstall 47 DMEs at ILSs, and convert 94 VORs to DSB DVOR.

# F.4.8 Microwave Landing System (MLS)

Responsible Division: AND-30
Contact Person: Richard Arnold, 202/267-8709

## Purpose

*To develop and implement a new common civil/military precision approach and landing system that will meet the full range of user operational requirements well into the future.*

This system will be the international standard replacement for the current Instrument Landing System (ILS).

The approach to accomplish the program objectives concentrates as much on the user issues as on the technical issues. The international requirements for this system are on a firm foundation and there are vendors in several countries that manufacture at least the Category I version of the MLS. There are also several manufacturers of the basic avionics sets. Some users at this time are questioning the benefits of equipping with MLS, given possible alternatives of improvements in the ILS, and the potential use of satellite-based systems for precision approaches. Other users are willing to equip with MLS to use its inherent advantages over ILS. In December 1988, OST approved a new MLS implementation strategy and a nine-point demonstration program to ascertain the economic and operational benefits of MLS.

## Program Milestones

All nine evaluation activities within the demonstration program are scheduled for completion in FY1991. An interim report was given to Congress in May. The program to compare the frequency congestion potential of MLS and ILS has issued its report showing the limited number of ILS frequency allocations available in several major metropolitan areas. Advanced approach procedures in wide body aircraft have received favorable ratings from the airline crews flying very short final curved segments in a 747 simulator. Simulation of advanced procedures in a multi-airport environment determined the benefits of MLS approaches to airports in the New York, Chicago, and San Francisco areas. To evaluate the general aviation/commuter capacity enhancements, MLSs have been installed at JFK and Chicago Midway. Work has been underway on technical comparisons of ILS/MLS. Activities focusing on minima reductions are underway, including assessments of decision height and other MLS Terminal Instrument Procedures (TERPS) standards. A contract has been awarded to design a low-cost Precision Distance Measuring Equipment (DME/P) interrogator which will be used as part of the evaluation program, and then be made available to other manufacturers. MLS avionics costs have been analyzed for all categories of aircraft. Activity is underway to work with a major aircraft manufacturer to certify an entire class of aircraft for MLS Category III operations.

The 1984 contract with Hazeltine to produce and install 178 Category I MLSs was terminated in August 1989. This contract represented less than 14 percent of the FAAs requirement for 1,250 MLSs to replace the ILSs. A second procurement of 1,250 Category II/III systems will occur at the successful conclusion of the demonstration program. A request for proposal was issued in 1990 and two vendors will be chosen in 1991 to design and produce prototype Category II/III ground systems.

To meet the demand for MLSs for the operational and economic evaluations of MLS benefits, up to 28 FAR Part 171 Category I MLSs will be procured. A contract has been awarded for the first two units, and they have been installed. The second procurement for up to 26 units was awarded in June 1991. The units will be installed starting in June 1992.

The FAA's transition plan will provide an MLS at every commissioned ILS location until parity is reached, at which time the MLS will become the primary system in the United States. Following a reasonable time period to allow the air carriers to equip, ILS systems will be decommissioned in a structured, and coordinated fashion.

## Products

- Up to 28 FAR Part 171 Category I MLSs
- A DME/P interrogator design
- Demonstrations of the MLSs operational and economic benefits from the nine-point evaluation program
- Approximately 400 Category II/III MLSs will be delivered from 1995 to 1999 with our international commitments met by January 1998, and an additional 850 will be delivered after 1999
- Modifications to TERPS and approach procedures to effectively integrate MLS into the ATC system

## F.4.9 Runway Visual Range (RVR) Systems

Responsible Division: ANN-200
Contact Person: John Saledas, 202/267-6529

### Purpose

*To establish and modernize existing Runway Visual Range (RVR) systems on qualifying Category I, II, III a/b ILS and MLS runways. RVRs support precision approach landing operations.*

RVR equipment provides real-time measurement of visual range along the runway. The RVRs in the NAS utilize old technology and cannot be economically upgraded to satisfy the requirements of the NAS in the 1990s and beyond. A new generation RVR has been conceived to economically satisfy all future NAS operating and maintenance requirements.

### Program Milestones

A contract has been awarded to procure 528 RVR systems. The RVR systems have completed all factory required testing. Production systems are scheduled for delivery in FY1992 - 93.

### Products

- 528 RVR systems with proper documentation

## F.4.10 Airport Planning and Design

Responsible Division: ACD-100
Contact Person: Thomas J. O'Brien, 609/484-4129

### Purpose

*To improve airport designs to reduce runway occupancy and taxiing time and enhance aircraft ground operations.*

### Program Milestones

Studies will be conducted to improve airport design and configuration to decrease runway occupancy time and taxiing time from runways to gates and back to runways; an increase in airport capacity is expected to result from these studies. In addition, current and improved airport designs and configurations will be evaluated for compatibility with new aircraft.

Simulator evaluation of the exit design was initiated in FY1989. An exit design was completed for demonstration at a specific airport in FY1990. In FY1991, simulator evaluation of exit designs will continue and acceptable designs will be provided for demonstration at additional airports.

In FY1991, analyses of current airport designs for compatibility with new aircraft will be initiated and will be completed in FY1992. Requirements for clearances, fillets, curves, and aprons are considered in this work. Results will be used to recommend improvements in airport designs.

In FY1991, analyses of multiple exit/taxiway/crossover designs will be initiated to determine the increase of aircraft flow rates afforded by the multiple systems over the current single lane system. The multiple systems are expected to handle more aircraft per unit time from runways to gates to runways, relieve gate congestion, and increase airport capacity.

### Products

- Technical reports
- Computer programs and users guides
- Design criteria and guidelines for airports
- Test methods and procedures
- Analysis methods

## F.4.11 Visual NAVAID

Responsible Division: ANN-300
Contact Person: Charles Ochoa, 202/267-6601

### Purpose

*To provide enhanced safety-related visual NAVAID at airports.*

The facilities to be provided are medium intensity approach lighting system with runway alignment indicator lights (MALSR), runway-end identification lights (REIL), precision approach path indicator (PAPI), and omnidirectional airport lighting system (ODALS).

This program also includes the retrofitting of remote radio controls for visual aids to meet the operational requirements of air traffic controllers. The new system will permit single-button control of each visual aid function.

The establishment of visual NAVAID projects are based on each region submitting qualified candidates. In addition, the President's Task Force on aircrew complement recommended the installation of vertical guidance capability at all air carrier runways, and those locations not equipped with vertical guidance devices will receive priority consideration.

### Products

- Current Capital Investment Plan (CIP) planning envisions the installation of 200 additional MALSRs, 300 REILs, 400 PAPIs, and 200 ODALs in the FY1993 and beyond time frame.

## F.4.12 Precision Runway Monitor (PRM) for Closely Spaced Runways

Responsible Division: ARD-300 (R&D), ANR-300 (implementation of F&E systems)

Contact Persons: Ken Byram (R&D), 202/267-3081
Pike Reynolds (F&E), 202/267-7632

### Purpose

*To assess and demonstrate the feasibility of applying Precision Runway Monitor (PRM) to increase the aircraft arrival rate at airports with closely spaced runways and develop the necessary equipment.*

An airport's capacity to handle arriving aircraft is limited by the number of runways that are usable at any one time. In instrument meteorological conditions (IMC), the number of usable runways depends on the spacing between the runways. Without PRM — an enhanced radar and an associated controller display — simultaneous dependent and independent approaches are only allowed if runways are spaced at least 4,300 ft apart. With PRM, the spacing required between closely spaced runways is reduced to 3,400 ft. This change would allow more airports to conduct simultaneous and independent approaches during inclement weather.

This project demonstrates the increases in an airport's arrival capacity that are possible with enhanced radar and controller displays. It will also produce a series of measurements on the effect of navigational accuracy, effect of the distance between the parallel runways, and response times of controllers, pilots, and aircraft. These measurements will also be useful in other similar applications such as triple and quadruple parallel runways.

### Program Milestones

Two engineering models of secondary beacon radars were tested. An electronically scanned (E-scan) beacon radar capable of a 0.5 second update interval (compared with a 4.8 second update interval available from today's radars), and a system that uses Mode S monopulse processing on back-to-back beacon antennas mounted on a conventionally rotating ASR system, capable of a 2.4 second update interval. The demonstrations of both E-scan and Mode S, begun January 1990, used improved 20 by 20 inch displays that were acquired in 1989.

In FY1990-91, engineering models were successfully demonstrated in conducting independent IFR approaches to parallel runways spaced 3,400 ft. apart. As a result, simultaneous IFR approaches to the proposed triple and quadruple parallel runways at Dallas/Ft. Worth Airport have been approved. Simulations of independent parallel IFR approaches to runways spaced 3,000 ft. apart using 1 mrad, 1 second update rate were conducted in FY1991. Further research and development will be required before simultaneous IFR approaches at spacings below 3,400 ft. can be approved.

Specifications, both for the modifications to the Mode S system and for the production E-scan systems were prepared. Implementation of the E-scan system is at a greater cost than implementation of the Mode S, but provides a faster update rate. Information on which update rate is suitable at which airports is an expected outcome of the demonstration.

### Products

- Operational requirements definition
- Automatic blunder-detection algorithms
- Validated runway separation model
- Measured performance of displays, blunder-detection algorithms, and E-scan and Mode S sensors
- Evaluation and procurement specification for production sensors or sensor modifications
- Operational procedures and guidelines

# F.4.13 Airport Capacity Improvements

Responsible Division: ARD-300
Contact Person: Gene Wong, 202/267-3475

## Purpose

*To develop ATC concepts and procedures to reduce airport delays by more fully utilizing the capacity of multiple runway configurations during Instrument Meteorological Conditions (IMC).*

Air traffic procedures and flight standards criteria for simultaneous triple and quadruple Instrument Flight Rules (IFR) parallel approaches will be developed and validated. Requirements and techniques for improved surveillance and navigation capabilities will be developed to support these procedures.

Studies sponsored by the FAA and the aviation industry have identified operational concepts with the potential to reduce airport arrival delays by better utilizing multiple runway configurations in IMC. These concepts include simultaneous and independent IFR parallel approaches to triple and quadruple parallel runways. ATC procedures and associated navigation and surveillance techniques for implementing the triple and quadruple IFR parallel approaches will be developed. Promising concepts will be validated through ATC simulations and, in some cases, full-scale demonstrations at airports.

Initially, multiple IFR parallel approach procedures for Dallas-Ft. Worth Airport, which has planned the addition of third and fourth parallel runways, were developed in order to gain technical and operational insights, as well as to help expedite the implementation of such procedures. This is being followed by the development of national standards for triple and quadruple IFR parallel approaches based on the current Airport Surveillance Radar (ASR) capabilities. The final phase of the multiple IFR parallel approach procedure development will focus on national standards based on Precision Runway Monitor (PRM) demonstrations being tested at Memphis and Raleigh-Durham Airports.

## Program Milestones

In FY1990, simulation evaluation of simultaneous IFR approaches to the proposed triple and quadruple parallel runways at Dallas-Ft. Worth Airport with controller participation were completed. The Nation's first triple and quadruple parallel IFR approach procedure was approved early in FY1991 for the proposed runways at Dallas.

In FY1991, simulation evaluation of simultaneous IFR approaches to parallel runways spaced 5,000 ft. apart, using existing ASR and displays, was completed. Recommended standards for use of this equipment were developed. Also, simulations of dual and triple runways spaced 3,000 ft. apart, using the PRM and displays, were conducted. Additional research in this area is planned in FY1993.

Simulations of triple parallel IFR approaches to runways spaced 3,400 feet apart using PRM with 2.4 second update rate and simulations of triple parallel IFR approaches to runways spaced 4,300 feet apart using ASR-9 and new controller displays with automated alert features are planned. These simulations will begin in late FY1991 and continue through FY1992. Analysis and simulations of quadruple parallel IFR approaches will also begin in FY1992.

## Products

- Simulation analysis of ATC procedures
- Flight procedures and system requirements for simultaneous IFR approaches to triple and quadruple parallel runways

## F.4.14 Airport Surface Visual Control (Lighting)

Responsible Division: ACD-100
Contact Person: Thomas J. O'Brien, 609/484-4129

### Purpose

*To provide concepts and criteria for improved lighting, marking, and signing devices. These concepts and criteria will improve airport safety by providing better guidance in low-visibility conditions.*

### Program Milestones

The efforts in this program will be accomplished by developing and testing improved lighting, marking, and signing devices for the ground guidance of aircraft at very low visibility conditions. New concepts for lighting and its energy sources, as well as self-contained systems requiring little or no maintenance, will be investigated. Tests of promising systems and concepts will be initially conducted at the FAA Technical Center. When necessary, improved systems will be validated by field tests at operational airports. Recommendations will be developed for incorporation of the improved lights, markings, and signs in the Advisory Circular.

In FY1991, an effort was initiated to determine specifications for a lighting simulator and to further develop recommendations (in the form of a research report) for design criteria for the following visual guidance systems:

- Stop-bar system test at JFK
- Markings for holding aircraft in low-visibility conditions (Sea-Tac)
- Hold-short lighting system for Boston
- Improved taxiway exit identifier
- Improved circling guidance from runway lights

### Products

- Research reports and design criteria
- Lighting standards for airports

## F.4.15 Development of "Land and Hold Short" Runway Warning Lights

Responsible Division: ACD-110
Contact Person: Paul H. Jones, 609/484-6713

### Purpose

*To develop and test a visual guidance system intended to indicate to the pilot the point at which he must stop his aircraft on rollout after landing on a runway which intersects with another active runway, thus ensuring safety and increasing capacity on airports having intersecting runways.*

### Program Milestones

During FY1991, testing of a prototype system at Boston Logan Airport was completed. A draft report on the prototype system will be completed by FY1992.

### Products

- Specifications for a pulsing, white, in-pavement lighting system arranged as a "bar" across the landing runway.

## F.4.16 Development of ATC-Controlled Stop-Bar Lighting System

Responsible Division: ACD-110
Contact Person: Paul H. Jones, 609/484-6713

### Purpose

*To develop, test, and evaluate prototype ICAO-modified-standard stop-bars installed at the intersections of taxiways with runways.*

*To obtain operational, maintenance, controller workload, and human factors experience in use of stop-bars to prevent runway incursions in all visibility conditions.*

### Program Milestones

Operational testing of stop-bars at JFK was begun in FY1991 and will be completed in FY1992. A final report on the use of stop bars that will provide airport operators with information on maintenance requirements and air traffic personnel with operating procedures for the use of stop-bars will be issued.

### Products

- Report on maintenance requirements and operating procedures for control of runway access using stop-bars.

## F.4.17 Evaluation of Airfield "Smart Power"

Responsible Division: ACD-110
Contact Person: Paul H. Jones, 609/484-6713

### Purpose

*To test the prototype system components of a Swedish/CAA-developed system for controlling lighting devices on airfields.*

This system superimposes a coded control signal on existing power cables, providing a capability to turn individual lights on and off. Such a system could, through selective control of circuits, light only those lights needed to guide pilots along preferred routes or even sequence the lights to progressively guide pilots.

### Program Milestones

The acquisition and installation of the components of a "smart power" system is planned for FY1991. This will enable testing of the system which will continue through FY1992. The completion of a final report that will provide data to the FAA Office of Airport Standards for use in developing standards for the use of "smart power" is planned for FY1993.

### Products

- Draft report identifying potential U.S. applications of Airfield "Smart Power," evaluating the effectiveness of the applications, and evaluating the compatibility of such a system with existing and proposed U.S. equipment.

## F.4.18 Development of Cockpit Airfield Surface Maps for Ground Navigation

Responsible Division: ARD-50
Contact Person: Mike Harrison, 202/267-8556

### Purpose

*To develop an onboard position-tracking avionics capability, initially based on LORAN or GPS navigation systems, that uses airport maps stored in memory.*

*To evaluate the suitability of providing pilots with guidance in the cockpit to assist in navigation on the airfield surface in low visibility conditions as a way to reduce the likelihood of runway incursions.*

### Program Milestones

Research is underway to identify the capabilities and accuracy requirements of a prototype system. A draft report completed in FY1991 will be used to develop the system requirements in FY1992. Demonstrations of LORAN/GPS/INS-based prototypes and glass cockpit demonstrations are planned for FY1993.

### Products

- One week devoted to GPS at FAA Technical Center in FY1991
- System requirements for position-tracking aircraft avionics
- Prototype demonstration

## F.4.19 Pavement Strength Durability and Repair

Responsible Division: ARD-200
Contact Person: Aston McLaughlin, 202/267-8694

### Purpose

*To provide support, through research and development, for the rulemaking and advisory mission of the FAA in setting minimum acceptable standards for airport pavements.*

This program involves material quality, design, evaluation, construction, and maintenance that will assure airport pavement integrity and longevity.

The FAA sponsors research on methods to arrest premature deterioration of pavements and to develop new or improved criteria for materials at the request of airport owners, operators, and industry groups. Surveys, studies, and tests are conducted to determine improved pavement performance and longevity. Where necessary, laboratory investigations are performed or prototype test pavements constructed to verify findings before making recommendations for new or improved criteria.

The FAA provides guidelines on new cost-effective approaches, design and construction techniques, and methods for enhancing the strength and durability of geotechnical materials suitable for use in airport pavements. These materials must be strong enough to sustain repeated wheel loading, must be insensitive to changes in temperature and moisture, and must be free from susceptibility to frost damage and thaw weakening. Certain polymers and resins have also been used on an experimental basis and on a limited scale. Acceptance criteria and pavement adjustment factors being developed will be field validated. This project also will investigate the use of reinforced aggregate and marginal materials for airport pavements.

In parallel with the development of better pavement materials, improved analytical techniques for pavement design and evaluation will be formulated. These techniques will provide an accurate assessment of pavement response to different aircraft wheel loadings, and will model the effects of variations in temperature and moisture on new pavement joint configurations. These analytical techniques will be programmed for computation on personal computers, and the programs will be streamlined and improved as much as possible to decrease computation time. Test methods will be developed to provide material-property parameters required by the improved analytical techniques for pavement design.

Finally, this project will develop improved methods of nondestructive structural testing, evaluation, and rehabilitation. Runway smoothness criteria that limit aircraft vertical accelerations will be established and analytical methods will be developed to determine the deterioration of runway smoothness.

## Program Milestones

In FY1989, a methodology was completed to provide guidance on the use of lime, cement, fly ash, and coal-tar seal coatings for airport pavements; efforts continued on quality control and acceptance criteria. Work was initiated to develop a unified methodology for the design and evaluation of pavement strength to devise guidelines for the application of novel construction technology.

In FY1990, studies were conducted on the use of marginal materials and polypropylene fibers to reduce pavement wear. Those studies are still in progress and are expected to be completed in FY1994. Work will continue on the evaluation of a new drainage system in FY1991 (plastic core and wrap). New quality control acceptance criteria will be completed and made available to appropriate airport officials. Also to be completed in FY1991 is a study on non-destructive testing methodology and layered elastic design.

In FY1991, new polymer fibers were evaluated for their ability to reduce cracking, decrease maintenance costs, and provide greater strength and durability to pavement components. These binders must be cost effective when produced in quantity, environmentally acceptable for use in construction, and energy efficient in production and use.

Efforts to develop a unified design and evaluation methodology are in progress and will be summarized in a report. The theoretical portion is to be completed in FY1993. The laboratory validation is expected to be completed in FY1996. A product of the project will be computer software that can be used by airport pavement designers. Users guides will be issued and the relevant advisory circulars will be updated or portions replaced.

## Products

- Technical reports and procedures manuals
- Design and analysis software and users guides
- Test methods and nondestructive testing methodology
- Guidelines and criteria for pavement design, construction, and maintenance

# F.4.20 Wake Vortex Research

Responsible Division: ARD-50
Contact Person: Mike Harrison, 202/267-8556

## Purpose

*To establish an acceptable strength threshold for wake vortex encounters leading to development of flight simulator scenarios to measure pilot performance.*

*To evaluate the feasibility and benefits of reclassification of aircraft from three to four categories.*

*To develop a set of new, reduced wake vortex separation standards for use by ATC, starting with heavy-behind-heavy separations.*

*To characterize wake vortex transport and decay close to the ground and between closely-spaced parallel and intersecting runways as a function of meteorological conditions.*

*To determine the time interval for a safe departure on the same and on intersecting runways.*

## Program Milestones

In FY1991, wake vortex signatures of B757 and B767 aircraft were collected and data was collected to measure the decay and transport of wake vortices under varying meteorological conditions at Dallas-Ft. Worth International Airport.

## Products

- Wake vortex encounter characteristics and creation of flight simulator scenarios to evaluate pilot performance and for use inpilot training
- New aircraft wake vortex separation criteria
- Runway spacing criteria, starting with heavy-behind-heavy
- Specifications for a VFR vortex warning device
- Time-based separation criteria for departures to support terminal air traffic control automation

## F.4.21 Visual Guidance System Simulation Capability

Responsible Division: ACD-110
Contact Person: Paul H. Jones, 609/484-6713

### Purpose

*To develop a visual simulation capability for use in visual guidance research and development to improve the ability to assess pilot acceptance of visual guidance changes.*

### Program Milestones

The contract for a requirements study will be awarded in FY1991 and the system specifications for the facility will be developed in FY1992. The project design cost/benefit analysis is also expected to be completed in FY1992.

### Products

- Definition of requirements for hardware and software development for a visual flight simulator

## F.4.22 Synthetic Vision Technology Demonstration (Joint FAA/DOD/Industry)

Responsible Division: ARD-200
Contact Person: Malcolm Burgess, 804/864-1905

### Purpose

*To demonstrate and document the performance of a low-visibility, visual imaging aircraft landing system based on millimeter-wave sensor technology that will complement existing and evolving landing guidance capabilities.*

### Program Milestones

The Synthetic Vision Technology Demonstration Program is divided into three concurrent activities. Activity I consists of Development and Test of Sensors. Activity II consists of Sensor Integration/Technology Demonstration, and Activity III is concerned with Certification Issues.

Design studies of alternative sensors were completed. Based on these studies, one sensor was selected for development, test, and evaluation. Delivery of a sensor for testing is scheduled for FY1991 and tower and flight tests will be conducted.

Simulation studies of human factors and other design parameters will be conducted in FY1992 to resolve design issues for the demonstration system. Evaluation and demonstration flights of the functional prototype system on a Gulfstream II aircraft are planned for FY1992. These flights will document and demonstrate system performance in measured weather conditions (fog, rain, and snow) using a cross-section of pilots in takeoff, approach, landing, and taxi phases of operation.

A draft Advisory Circular has been developed that identifies certification issues and processes to be used by FAA and industry. The final version of the Advisory Circular on Synthetic Vision is planned for completion in FY1993.

### Products

- Functional prototype of a weather-penetrating synthetic vision sensor
- Report identifying certification issues and outlining potential certification methodology
- Sensor and system performance documentation
- Flight demonstrations